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FUTURE WAR PAPER

Squaring the Triangle:
The future medium-sized ground tactical vehicle

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Executive Summary

Title: Squaring the Triangle: The Future Medium-Sized Ground Tactical Vehicle

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Thesis: This research will explain that if the Marine Corps lead a multi-service effort that prioritizes the expeditionary transportability of medium-sized, ground tactical vehicles, then a lighter, smaller and more agile fleet of vehicles will emerge to better support the military of the future.

Discussion:

Today's military vehicles have outgrown their expeditionary transportability as a result of seven years of acquisition programs that have fielded military vehicles which solely focus on the immediate requirements of the deployed forces in the current fight and not on how such equipment will be part of the military of tomorrow. This paper focuses on transportability problems facing the military's medium-size fleet of vehicles.

As a result of this dilemma, the Marine Corps has teamed up with the US Army and has established a joint tactical wheeled vehicle strategy. This strategy currently uses an "iron triangle" model to help industry designers to conceptualize the balancing of three core functions the military has determined future medium vehicles must maintain: payload, performance and protection. Yet, the "iron triangle" fails to recognize the overarching importance of a vehicles expeditionary transportability. As a result, newly designed vehicles, like the Joint Light Tactical Vehicle program, offers technological advancements in vehicle design, but ignores the physical limitations of transporting such a vehicle to a contingency. If a commander cannot deploy his equipment to where it is needed, his strategy and tactics are limited. As a result of the JLTV inability to be transported by current means, the Marine Corps is withdrawing from the program.

To avoid such complications in the future, the Marine Corps should lead the joint effort in redesigning the future medium-sized tactical wheeled vehicle. The Marine Corps should also act on its instinct and incorporate a fourth core function, transportability. By adding a fourth function, and squaring the iron triangle, the Marine Corps could design a better, more balanced vehicle that employs payload, performance and protection within a transportable package.

Conclusion:

The Marine Corps is the service most limited by the restrictive nature of strategic mobility assets, particularly US Navy amphibious ships. Thus, it has particular interest to ensure future acquisition programs for medium-sized tactical wheeled vehicles include expeditionary transportability as a core function. By leading a joint program and incorporating an "iron square," a lighter, smaller and more agile vehicle will be designed for the joint forces.

Disclaimer

The opinions and conclusions expressed herein are those of the individual student and do not necessarily represent the views of either the Marine Corps School of Advanced Warfighting or any other government agency. References to this study should include the foregoing statement.

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"Logistics comprises the means and arrangements which work out the plans of strategy and tactics. Strategy decides where to act; logistics brings the troops to this point."
- General Antoine Henri Jomini

Introduction

It's too heavy. That is a common description of today's military equipment, particularly the US Marine Corps' tactical wheeled vehicles, as the Nation comes to recognize the drastic result of seven years of combat operations in Iraq and Afghanistan. Today's military vehicle development and acquisition programs have become so preoccupied with additional force protection measures and bolt-on equipment that they have produced vehicles that support a single, unique environment. As a result, once agile forces like the US Marine Corps have become heavier, inflexible land forces. The Marine Corps as an institution is an expeditionary force that deploys from the sea, yet its tactical wheeled vehicles have changed so much in the past seven years that they are now more tailored for long land war than deploying from naval shipping. Their use of the word "expeditionary force" has become merely a title. Worse yet, in rushing to meet the emergent conditions cast by today's battlefield, our military services have forgotten to posture their forces for the battlefield of tomorrow.

Fortunately the overweight state of Marine Corps equipment has been recognized by its leadership. Its Commandant, General James T. Conway, has mandated that his leaders "posture the Marine Corps for the future" by conducting "an informed assessments of potential future security environments" and examine "how they relate to the functions of organize, train, and equip." [1] For future wheeled vehicles programs, the Marine Corps is implementing this guidance by entering a joint tactical wheeled vehicle strategy with the US Army. The joint strategy's goal is to better balance the varying, often competing capabilities of a new vehicle requirements to

satisfy each of the services. Although the joint strategy will serve each vehicle family, light, medium and heavy; it is the medium-size fleet that will be addressed in this research, as the medium fleet of tactical vehicles that has the greatest potential for expanded roles on battlefields of the future. Throughout history the medium truck has been the workhorse of the military's wheeled vehicles, and as other families of vehicles become more specialized in capability, the medium fleet will be relied upon to provide a "mobile, reliable, and flexible ground transport" that performs in every climb and place.[2] Therefore, it is critical that any joint strategy employed effectively balances not only each service's operational requirements, but also address the transportability restrictions of today's mobility assets that today's vehicles do not. To a degree, the Marine Corps recognizes those restrictions and is in the best position of all services to determine the vehicle's strategic balance. This research will explain that if the Marine Corps lead a multi-service effort that prioritizes the expeditionary transportability of medium-sized, ground tactical vehicles, then a lighter, smaller and more agile fleet of vehicles will emerge to better support the military of the future.

Why the Marine Corps?

First, it is important to note that not all services use the same mix of tactical wheeled vehicles, particularly in the medium-size family. This is a result of varying operational requirements, service force structure and acquisition processes. Left alone, the Marine Corps might correct its current predicament by redesigning its medium-sized wheeled vehicle fleet as per its Commandant's latest guidance. However, in September 2009 the Government Accountability Office (GAO) suggested that the Secretary of Defense "develop a comprehensive and unified strategy and implementation plan for making sound investment decisions for tactical wheeled

vehicles."[3] This means US military services will no longer independently design future tactical wheeled vehicle fleets but will instead have to work together, jointly, in creating new vehicles.

With this direction, the Marine Corps has implemented a new tactical wheeled vehicle strategy, in conjunction with the US Army, in an attempt to harmonize their efforts. This co-sponsored tactical wheeled vehicle strategy is likened to balancing an "iron triangle."[4] The iron triangle comprises of what the two services have determined are the tactical wheeled vehicle's three core functions: payload, performance and protection. The Army and Marine Corps surmise that in balancing these functions they will achieve a common tactical vehicle design that supports all of their requirements.

Unfortunately, within the iron triangle strategy, the prerequisite of vehicle transportability was not identified as a core function. Transportability is defined as the capability of material to be moved by towing, self-propulsion, or carrier via any means, such as railways, highways, waterways, pipelines, oceans and airways.[5] This function will largely define the strategy and tactics a military can use based on the materiel it can bring, or transport, to the conflict. Simply put, if tactical vehicles are too big to rapidly transport to a contingency, then strategic and tactical options available to the commander are limited. As important as this function is, the "iron triangle" instead categorized "transportability" as a sub-function within "performance."[6] This simple oversight in prioritization will impact the design and acquisition process and mean the transportability of future vehicles will be overlooked for other seemingly more important functions. Rather than address today's problem of being too heavy, the iron triangle strategy simply prolongs it.

Recognizing this problem is critical, and because the Marine Corps has, it positions itself as the service most apt to find a solution. In being "expeditionary" in nature, the Marine Corps is more influenced by the enduring and restrictive limitations of US Navy amphibious ships than other services and their modes of transport. In order to deploy on amphibious shipping, Marine Corps equipment must remain within certain criteria of height, weight and cubic dimensions simply to fit within stowage. For medium vehicles, the mandated height, weight and cubic dimension threshold will vary based on where the vehicle is stowed, and on which variant of ship. Ultimately this means that the total number vehicles to fit within a ship will be limited by where the vehicle can be physically driven, where it can physically fit (considering both ship stability and physical dimensions), how much stress (weight) the vehicle puts on the ship, and finally the type of landing craft the ship uses to deploy the vehicles.

Another challenge in the Marine Corps' marriage to amphibious shipping is that the lifecycle of a US Navy ship is twice as long as that of a ground tactical wheeled vehicle. This means that a Navy ship placed into service today will be the transportation platform used by the Marine Corps for the next 40 years.[7] The time required for ship development is an additional limitation. For instance, the newest amphibious dock ship of the 21st Century, the Austin Class LPD-17, was commissioned in 2006 and is the most modern amphibious platform at sea today.[8] Yet the LPD-17's vehicle stowage was designed to transport the outdated M939 medium-vehicle fleet, commonly known as the 5-ton truck, not the larger and heavier 7-ton truck of today. Therefore, it is critical that the military's tactical wheeled vehicle strategy adjust its truck design to meet the

transportability limitations set by amphibious ships. The Marine Corps is an obvious choice to lead such an effort.

We should recognize that giving the Marine Corps the lead in developing the medium vehicle would be a unique situation. The Marine Corps is the smallest of the US military services, it requires far fewer vehicles than the Army, and it levies the most unique transportability requirements on such a program. For these unique reasons, large multi-service vehicle design and acquisition programs tend to fall to the US Army. Considering this, there are two important issues to address that are highlighted by a present day example.

First, as future vehicle fleets will be developed in a joint environment, vehicle designs must now best address the requirements of each of the services. This sounds logical, but is not necessarily the case. Although the Department of Defense's (DoD) Joint Requirements Oversight Committee (JROC) ensures DoD acquisition programs are not redundant in nature, such oversight does not mandate that a service-lead actually meet another service's requirement. Thus, a program's service-lead does have the ability to steer program development so certain requirements are deemed impractical or expensive. This empowerment has led to problems with the joint light tactical vehicle, which will be addressed next.

The second issue to address is the joint services defining of the role a medium wheeled vehicle will play on future battlefields. Defining the vehicle's role helps determine the sophistication and cost of the vehicle's design, which in turn determines how the vehicle is employed and in how many produced. Technologically advanced vehicles will be more expensive, but their

increased ability on the battlefield might decrease the need for high production numbers. At the same time, an advanced system might actually change the vehicles intended role, therefore requiring other vehicles to accomplish the original mission.

In both of the above issues, differing service-lead priorities and role definition have complicated the new, light vehicle program and it must be studied to avoid similar problems in the medium fleet. The joint light tactical vehicle, or JLTV, is an Army-led, multi-service program to design a future light tactical vehicle which integrates the utility of the present-day high mobility multi-wheeled vehicle (HMMWV) with the protective capabilities of the mine resistant armor protected (MRAP) vehicle.[9] The Army believes their solution to this vehicle is "evolutionary, moving from a threat-based Cold War garrison force focused on containment to a capabilities-based expeditionary force, focused on flexibility, responsiveness, survivability and agility."[10] However, the prototype JLTV not only exceeds the transportability limitations set forth by the Marine Corps, its large size fails to conform well to any mode of transport, civilian or military. This is mostly due to how the Army sees the JLTV operating on the future battlefield, and the capabilities it thinks the vehicle must possess. Meeting the Marine Corps more restrictive requirements would have made the JLTV too small to handle the Army's requirements; thus, they focused on vehicle performance over transportability. As a result, the Marine Corps has opted out of the JLTV program, faulting industry for failing to stay "apace of the vision."[11] This means the Marine Corps could resort to reconditioning and refitting their outdated HMMWV fleet and not only perpetuates their current dilemma, but also fails to address the GAO's concern with excessive spending in vehicle programs.

What if the Marine Corps were the lead?

As JLTV program demonstrates the difficulties of a multi-service program, one might question what would be different if the Marine Corps lead a medium-sized vehicle program. For one, based on its Commandant's guidance, the Marine Corps would be more likely to add transportability as a core function, along with payload, performance and protection. By adding this fourth function, the Marine Corps would in fact "square" the "iron triangle," giving the tactical wheeled vehicle strategy a more stable foundation. To forecast how such a program might progress, this paper will examine the original core functions of the "iron triangle" through lens of transportability, the recommended fourth function. By doing so, a vision of what might be produced will be offered, should the Marine Corps be given the lead for a medium-size vehicle program.

Payload

In developing a cargo truck, the balance of the four core functions should naturally favor the vehicle's primary mission of delivering a payload. To do this, vehicle development should focus on the cargo bed and its dimensions, to include its height off the ground and utility. From there, designers should build the truck around the bed. In this thinking, trade-offs in engine size, ground clearance and overall performance of the vehicle are considered before its payload and utility are reduced. Medium cargo trucks with large payloads are ideal multi-purpose vehicles, so by focusing first on the cargo bed the Marine Corps can ensure vehicle versatility. This concept also supports manpower, maintenance and sustainment on the battlefield, as fewer, more versatile trucks with greater payloads would be better for a military than more, mission-specific trucks offering less payload.

The cargo bed of today's medium-sized truck is designed for hauling troops, break bulk supplies, and standardized, intermodal containers. Standardized containers are those that meet international specifications set by International Organization for Standardization, internationally recognized as ISO. Intermodal shipping containers largely dictated the dimensions of modern military cargo beds, as incorporating them allows secure, intermodal movement of both military and commercial containers while also standardizing the material handling equipment in support. The discussion over how to best integrate intermodal containers into military logistics systems is an ongoing debate, and one that will affect future cargo vehicle design and use. Most agree that the ability to transship material using a single container allows faster, more streamline operations. However, for tactical units in austere locations, the utility of large containers (20 feet or more in length) decreases the further away they get from established logistics facilities.

During operations in Iraq, the US military used hundreds of thousands of 20 and 40-foot ISO containers to transship military cargo. Such extensive use of these large containers was a product of the static nature of the Iraq mission and robust infrastructure it developed. Yet, battlefields of the future could be much more austere, and the future medium-sized vehicle fleet designed to carry smaller, more compartmentalized or break-bulk supplies. Until large ISO containers can be easily handled in austere locations, the majority of future medium trucks cargo beds should not accommodate their length. This tactic not only eliminates unwanted bulk in supplies, but it also establishes a clear delineation between tactical and operational-level logistics. To keep forces light and agile, the medium-size fleet for tactical logistics needs accommodate break bulk supplies while the operational logistics fleet hauls large ISO containers.

Finally, this tactic of eliminating containers within tactical operations is also in line with future sea-basing techniques proposed by the Marine Corps, as large ISO containers have proven too large and unrefined when retrieving supplies from stocks within ship at sea.[12] The Marine Corps' future role in operating from sea-based platforms must have a medium vehicle fleet that not only incorporates how supplies will be moved from ship, but also in how the vehicle itself will be transported. The oversized dimensions of today's vehicles will stress the physical limitation and capabilities of floating platforms and barges, and even ship's cranes. Without properly integrating the payload capacity and the vehicle dimensions into these important requirements, the medium vehicle fleet will not support the lift requirements or the transportability within the sea-basing concept.

Performance

In designing a truck, if the first priority is on the cargo bed and its payload capacity, some might argue that this is putting the cart before the horse. If so, then defining vehicle performance traits must be the next step. However, as was discussed in examining vehicle payload, the transportability of future vehicle is the primary concern. This means that engine design and vehicle operating systems must fit within established parameters. By specifying this requirement up front, commercial vendors and vehicle designers will be required to develop vehicles that first and foremost fit the needs of the Marine Corps, and stay apace of the vision. Contrarians to this idea would say vendors should not be restricted in how they integrate performance capabilities into a vehicle; that the military should just specify the performance requirements and let the experts produce the solution. Unfortunately, this practice encourages vehicle evolution, allowing

vendors to reuse their current technologies or manufacturing practices rather than seek revolutionary concepts. By specifying required dimensions and defining the transportability box in which vehicle systems must exist, vendors will be challenged to meet the military's expectations rather than define them. The goal is to encourage size-reducing concepts while still revolutionizing the medium fleet's performance.

Challenging commercial vendors to revolutionize a fleet of ground vehicles sounds like an expensive venture for the military. However, with the GAO's recommendation to reduce DoD spending through joint vehicle programs, the military could actually fund expensive research in future technology by pooling its resources. In fact, the RAND Corporation conducted an analysis in 2008 on acquisition cost saving benefits by using commonality within military equipment, materiel inventory, logistics, parts, and training. Interestingly, one of the primary cost-saving benefits is realized in joint (or common) research and development of complex systems.[13] Thus, if a Marine Corps program were to challenge designers to develop a high performance vehicle system within a smaller, more transportable package, while providing the cargo bed and payload a medium vehicle is there to provide, the expenses in research and development could very well be recovered by eliminating other service ventures.

Other performance qualities to address when examining future medium-sized vehicles are how those vehicles will be operated and what their energy use, and production will be. First, although technology demonstrates the ability of unmanned ground vehicle operation, to date the requirement for vehicle operators is still valid. Multi-use vehicles support a variety of missions throughout the spectrum of military conflict, all possibly occurring in an amphibious or sea-

based environment. Vehicle operations in such complex settings might one day allow remote control operation, but the expeditionary nature and transportability of military command and control systems has yet to incorporate such capability. As such, future vehicles must retain their crewmembers for operation.

Vehicle energy, meaning both fuel consumption and electrical generation, is another future design consideration. Fuel use and fuel resupply on the battlefield are historic challenges, but initiatives for efficient hybrid engines and alternative fuels means the potential for reduced energy consumption. Although hybrid engines typically sacrifice higher performance for better fuel economy, with the necessary expenses in research and development such a compromise could be eliminated. Ideally, an increased in hybrid engine performance would allow an increased in available payload, as less fuel consumed would mean less fuel needed to be distributed by medium trucks. This is one example as to how vehicle research and development in payload and performance could provide overarching benefits on the battlefield.

Finally, an increase of electronic systems on the battlefield has placed an increase demand on electric generation in today's ground vehicle fleet. Not only are military services filling vehicle cabs with every variety of electronics for command and control, force protection, or vehicle diagnosis; electric generation is required to support external systems as well. As electronic systems are continuously advance and demand greater power supply, future vehicle designs must incorporate an expanded capacity for easy access electrical sources. Ultimately, vehicle "performance" must ensure its power generation supports its crewmembers demand.

Transporting a payload is the vehicle's primary role, but it cannot do so to the detriment of supporting its crew in accomplishing that mission.

Protection

Vehicle protection has been the most evolved aspect of today's tactical wheeled vehicles. The range of extremes from the canvas-topped HMMWV originally deployed into combat in 2003 to the million-dollar mine resistant, ambush protected (MRAP) vehicle operating today speaks volumes to that end. Yet, leaders today feel vehicle protection is more than just armor plating and that in order to reduce the weight of today's armored vehicles they must integrate other means to protect the force. Although an ideal approach, research and development for future medium-sized vehicles cannot neglect the integration of armor protection on its vehicles. Either due to battlefield threats or national public opinion, the ability to protect vehicle crewmembers by armor will remain a requirement.

In revolutionizing the vehicle fleet, a "best level" of protection must be either part of the vehicle's research and development cost or a considered a trade-off with other core functions. What this means is if future armor technologies do not allow an economic, MRAP-like protective shell to fit and weigh within the transportable, cargo-focused frame of the future medium vehicle, then the military services must either sacrifice the level of protection offered or a benefit from another core function. Considering that vehicle design and usable technology must start with what is available today, a realistic expectation between protection-level and weight must be made. If future armor is not reduced in weight, then reduced armor protection must be the trade-off for better transportability. This is a significant risk that other force

protection measures, such as electronic counter measures or vehicle tactics, must mitigate. Use of modular armor is one potential solution, but this "add-on" armor would also require strategic lift and transportation to reach the forces.

Finally, one of the largest physical additions to today's medium vehicle is the armored gun turret system. Gun turrets, or ring mounts for weapons, are traditionally installed on a percentage of the medium vehicle fleet to provide a level of self-protection throughout. Like the weighty evolution of protective armor, armored gun turrets have also grown in size and complexity, resulting in reduced payload of individual vehicles and less transportable vehicles overall. In fact, turret systems today extend so high above the vehicle's structure that they eliminate stowage in most holds on ship. To mitigate this, there are unmanned weapon systems available for use on medium-sized vehicles; however, where an unmanned weapon can reduce the gun turret's height, the system's complexity in control, power and arming brings new challenges to bear. It also begs the question of future cargo vehicles requiring such self-defense systems. Truthfully, vehicle designers must allow for the concept and ensure the weapons storage, function and ammunition are incorporated into the vehicle's overall payload, performance and transportability. History has proven that tactical wheeled vehicles require self-protection weapons systems, and future designs should ensure they are included.

Conclusion

Despite the challenges, there is no expectation that the future will not require medium-sized tactical wheeled vehicles to transport critical supplies off-road to ground maneuver forces. Technological advancements will continue to shape our military's strategy and tactics, and the

mobility and capability of medium ground vehicles will allow them to play a significant role. However, because ground tactical vehicles are such an integrated part of a series of complex deployment and sustainment systems, ranging from sea-basing strategies to the use of intermodal containers, any revolutionary design change in the medium fleet requires a foundation in its present state. What this means is that until radically new technology can be applied, or unforeseen changes in battlefield tactics and sustainment occur, the medium-sized vehicle must continue to serve its original role on the battlefield, albeit with improvements.

The Marine Corps is on the correct path for making those improvements. The Commandant's *Marine Corps Vision and Strategy 2025* clearly identifies the problem,

> "Ground mobility is a shortfall that must be remedied. As Marines, we are always aware of the size and weight limits that we live with to remain both operationally deployable by sea and tactically effective ashore. Every decision in this area must be carefully reconciled with these two considerations. A third factor is now equally important — we must provide adequate protection for our tactical mobility systems. Our goal is to provide a mix of survivable tactical vehicles that are compatible with expeditionary and amphibious deployment means." [14]

In that passage, the Commandant is describing the four core functions that square the current "iron triangle." Yet, although the Marine Corps recognizes the problem, the current joint tactical wheeled vehicle strategy will not produce the future vehicle the Army and Marine Corps require. They must recognize and embrace the physical limitations imposed by their modes of transport with long life cycles if they are to reclaim their expeditionary transportability. Otherwise the joint services will continue to limit the options of strategy and tactics available to their military commanders. Additionally, if future vehicle acquisition programs are not wedded to the four core function solution, an "iron square" if you will, then the military will continue to have wasteful and divergent efforts like the JLTV program.

Today's military vehicles are too big. If the joint services are going to fix this problem, then it must come from revolutionary changes that break from the current evolution of ground tactical wheeled vehicles, and a strategy that squares the iron triangle. The Marine Corps must lead this effort to ensure the medium-sized vehicle fleet remains expeditiously transportable while retaining payload, performance and protection standards. Tomorrow's vehicle will be lighter, smaller and more agile, and will redefine the military's expeditionary nature.

Notes

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